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Human Behavior Representation
Relevant Technologies
And Their Development

Dr. Robert Jacobs
Dr. Peter Brooks

Institute for Defense Analyses
United States of America

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Notes for Slide 1

Summary

This presentation gives an overview of the technologies relevant to human behavior representation. These are discussed in terms of individual versus team or group behaviors. The development process for including human behavior representation in simulations is reviewed. A set of potential future research activities is discussed.

Topics

- Goals
- Individual Behavior Representations
- Team, Group, and Organization Behavior
- Development Processes
  - Knowledge Acquisition
  - Interoperability and Composition
  - Validation
- Future Activities

Notes for Slide 2

This section gives an overview of the main research areas for Human Behavior Representation. The discussion is based on general goals in the major areas of defense activity: training, exercises, defense planning, operations, and acquisition. The primary technical gaps are identified. A few important areas to guide future research are presented.

Goals

- Training
  - Models of training subject and trainer to aid knowledge transfer
- Exercises
  - Models of groups to minimize exercise support personnel
- Operations
  - Models of command and control structures
- Acquisition
  - System usability models

Notes for Slide 3

The goal of instruction and training is to learn new skills and improve specific skills in individuals and teams. In order to support these tasks, it is necessary to develop a model of the subject of the instruction and training (the trainee or group), a model of the instructor and models of the inanimate systems, other human or human-operated platforms that the trainee(s) interact with. The model of the instructor includes evaluation or performance measurement models and models of the various strategies that can be applied to achieve the knowledge transfer objectives. In order to automate these models, they need to be made explicit and it is necessary to develop a suitable framework for HBR.

Exercises are aimed at maintaining and applying acquired skills. They also serve to generalise knowledge and increase the ability of individuals and teams to select and apply suitable knowledge. Exercises are key to the development of knowledge concerning the application of skills, also referred to as meta-knowledge. They typically require substantial interaction with other teams and the deployment of large numbers of personnel acting as exercise facilitators in the form of directing and response cell staff (representing opposing, neutral and friendly forces NGOs, PVO and others).

Notes for Slide 3 (Continued)

The challenge facing Command Information System Planners is defining command and control systems for the wide range of contingencies operations. Command and control echelons will need interfaces with non-governmental organizations and other entities. Command Information System Planners need sophisticated organizational modeling capabilities that will enable them to quickly investigate alternative command and control structures. Such models must be sensitive to cultural differences and be capable of analysing and organizations and their interactions.

A recent trend has been the integration of simulation with C3I system, and the real-time use of simulation to support operational decision-making. HBR will play a role in meeting future C3I challenges by providing support for information integration and course of action generation, as well as supporting advanced simulation-based tools.

Notes for Slide 3 (Continued)

There is a great need in the design of future systems to increase mission capability while reducing manpower requirements and overall cost. The challenge is to concurrently design new organizations, equipment, and human tasks in a radically different context. This is a different problem from engineering enhancements of legacy systems, which is the historical norm. Given the lack of analogies and historical data provided by legacy-based design approaches, team and organizational models provide the only viable approach to quantifying and evaluating the organizational, team, and task-teamwork design of radically different future systems. Team-organizational models also provide a vehicle for equipment designers to evaluate the human impact of designs and design to human needs, from trainability and usability to planning for manpower requirements and recruiting.

Individual Behavior Representations

- Technology improvements needed in
  - Knowledge acquisition
  - Composability
  - Behavior moderators
  - Models for situation assessment and decision-making
  - Validation, verification
- Can result in less need for simulation operators

Notes for Slide 4

Scientific and technological gaps relating to individual HBR:

The following lists the technological gaps indicated in the current HBR use of both AI and psychological research within the implemented military M&S environment.

Knowledge acquisition is expensive and undocumented.

Current efforts are granularity locked, but need to be able to change the granularity of the model when an appropriate level is indicated, necessary, or desired with the capability to do so in development and in use.

Composability of modeling effort is lacking and necessary in relation to model development and revision.

Scalability of models is lacking.

Lack of required behavior moderators in current models produces models that are brittle, non-adaptive, and predictable.

Notes for Slide 4 (Continued)

Current models required extensive human manipulation and suffer from low usability.

No intent determination is used within current operational models.

No integrated cognitive processing architecture (situation assessment, decision making, and planning not integrated) is present.

Learning is limited in current models, if addressed at all.

No explanation capability is present to allow understanding of current model decision processes.

Verification, validation, and accreditation is not currently addressed.

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Team, Group, and Organization Behavior

- Technology improvements needed in:
  - Computational modeling of teams
  - Descriptions of team performance moderators
  - Modeling of team communications
  - Team performance models
- Applicable broadly to many types of simulation

Notes for Slide 5

Formal computational modeling of teams is currently in its infancy. Further data collection is required to clarify the underlying behavior using a formal scientific approach. The investigations of well structured military teams already conducted can serve as the foundation for the development.

The classification and formal description of team performance moderators is an area that needs urgent attention. A structure for understanding the nature of “internal” and “external” moderators is required, that includes the “internal” moderators for the members of the team – personality, ability, anthropometric characteristics, etc.

Communication is critical to team and organizational behavior. Substantial and better understanding is needed of the effectiveness and underlying processes and role of communication in general aggregate behaviors.

Backup behavior is also critical to team performance, and better understanding of the underlying processes is required before the appropriate technology can be developed.

Notes for Slide 5 (Continued)

The Measures of Performance (MOP) used for all levels of military organizations are inadequate both for regular processes such as training and for developing effective models of the aggregates.

The taxonomy of aggregates requires further investigation to establish a strong scientific foundation. A clearer understanding of the variables that differentiate between the different aggregates is required. It is probable that a different approach is needed for groups/crowds than for teams/organizations.

Data that can be used to validate models of teams and groups. Data is expensive so data reduction and re-use is important

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Process of Creating HBR

- Phases
  - Knowledge Acquisition
  - Validation
- Both time consuming and skill intensive
  - Potential to save time using composability (exists in some modeling domains)

Notes for Slide 6

The process of developing human behavior models is similar regardless of the application area. Currently available models are an outgrowth of research and development efforts – built for particular applications or to satisfy specific research goals.

There are two aspects of model development common to all application areas – knowledge acquisition and validation. At present the practice of acquiring knowledge upon which to build human behavior models is time- and skill-intensive, resulting in incomplete representations. Similarly the validation of human behavior models is time- and skill-intensive, often short-changed in the desire to complete the development cycle. The lack of useful tools and technologies hampers progress in knowledge acquisition and validation.

To enable more cost-effective development and to promote reusability across efforts, a more structured approach to human behavior modeling is advocated. The human behavior community must look to other research communities for tools and technologies that can be applied to human behavior representation. The concept of model composability is cited as a key to cost effectiveness within mainstream modeling, but the concept has not been fully explored in the context of human behavior modeling. Also the development of the High Level Architecture has allowed the interconnection of a diversity of simulations, but interoperable models of human behavior representation have not yet emerged.

Knowledge Acquisition

- Time consuming, using specialized skills, with little reusability
- Emerging developments
  - Cognitive architectures
  - Taxonomies of knowledge
  - Cognitive task analysis training
  - Techniques to elicit creativity from experts to address novel situations

Interoperability and Composition

- Technical interoperability of systems exists (e.g., CORBA)

- Emerging developments in Composability
  - Framework for describing HBR
  - Data exchange standards for HBR
  - HBR modules sharable among simulations

Validation

- Validation difficult due to lack of reference data
  - Use of subject matter experts costly

- Emerging developments
  - Verification, validation, evaluation and testing tools applied to production rule knowledge representations
  - But need methods to validate non-cognitive aspects of HBR

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Future Activities

- Develop generic behaviors linked to mission-oriented tasks
- Advance understanding of social influence on behavior
- Develop representations of both instructors, trainees, evaluators
- Models effects of information on behaviors
- Develop computational models of teams

Notes for Slide 10

To repesent human behavior in a military valid and possible exhaustive way, it is necessary to work within a defined common problem space and then to analyse mission types within this space in order to derive relevant military tasks leading to a satisfactory execution of that mission. To focus on the modeling of relevant behavior, the analysis of the mission types should be driven by a need analysis. In a second step, a particular job should be described in terms of a limited set of generic behaviors. Finally, this job description is to be seen as a framework for a learning and teaching tool.

A complete model of individual human behavior must always contain the three domains of behavior – cognitive behavior, motor behavior, and socio-affective behavior - and take their interactions into account in the execution of a military task within the defined problem space. Because the socio-affective aspects of behavior as moderators in overall behavior are not well understood and because the relationships between socio-affective behavior and cognitive and motor behavior have only been addressed in isolated and specific circumstances, an effort must be made in the study of socio-affective behavior.

A taxonomy of generic tasks expressed in terms of individual behavior within the military problem space is necessary and includes the following: planning, intelligence, situation assessment (Command and Control), maneuvering, target acquisition and weapon delivery, maintaining mobility and survivability, after action review.

Notes for Slide 10 (Continued)

A complete model, suited for instruction and training, must contain a representation of the behavior of the three players: instructors, student, trainee and third persons. Moreover, it is necessary, but difficult, to implement an intelligent tutoring system (ITS) and an adaptive aptitude-treatment interaction system (ATI), which is necessary as one moves from the support operations to the instruction application.

A high priority should be given to both planning and intelligence/situation assessment (Command and Control) to deal with the issue of information overload and eventually lack of relevant information. These tools must allow also for elaboration and evaluation of alternate plans and alternate courses of action. In the area of instruction and training, an intelligent tutorial system is required (saves personnel, easier composition of the training, broad application, allows interaction, provide automated after action review, reusable, etc.). The same arguments hold for after action review across other application domains; an intelligent observer is necessary to take full advantage in reuse of lessons learned and tutor when the application or exercise is completed.

Notes for Slide 10 (Continued)

Formal computational modeling of military teams, groups and organizations is currently not well developed. The fields of social and industrial/organizational psychology have yielded a number of useful concepts that can be exploited for military application. However, the critical shortfalls are that these concepts for the most part are informal rather than computational, and focused on civilian rather than military social entities.

A significant improvement in a priori predictive capabilities and force readiness is possible through improved HBR of teams and organizations. No program to achieve needed improvements in modeling teams and organizations exists at the present time for application in military simulation for instruction, training, and exercise, acquisition, support to operations and defence planning.

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Dr. Robert Jacobs
Dr. Peter Brooks
Institute for Defense Analyses
1801 North Beauregard Street
Alexandria, VA 22311
United States of America

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